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VERIFICATION OF A TRANSLATION

I, Charles Edward SITCH BA,

Deputy Managing Director of RWS Group Ltd, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England declare:

That the translator responsible for the attached translation is knowledgeable in the French language in which the below identified international application was filed, and that, to the best of RWS Group Ltd knowledge and belief, the English translation of the international application No. PCT/FR2003/002095 is a true and complete translation of the above identified international application as filed.

I hereby declare that all the statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the patent application issued thereon.

Date: December 17, 2004

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Heat exchanger support system and associated heat exchanger module

The invention relates to heat exchangers, particularly for motor vehicles.

Background of the invention

Motor vehicles are fitted with several heat exchangers. In particular, they comprise at least one heat exchanger for cooling the motor vehicle engine. They also frequently comprise several other additional heat exchangers such as a condenser forming part of the air conditioning circuit for the passenger compartment of the vehicle or a supercharge air cooler. These heat exchangers are frequently put together to constitute an assembly of several exchangers called a heat exchange module.

Description of the prior art

In the prior art as currently known, the radiator for cooling the vehicle engine is mounted on the vehicle chassis, usually via flexible fixing elements, such as rubber blocks allowing the vibrations to be damped. The other components of the heat exchange module, such as the condenser or the supercharge air cooler are in turn mounted on the engine cooling radiator.

This known solution has a certain number of disadvantages.

First, the elements for fixing the cooling radiator onto the vehicle chassis support the entire weight of the heat exchange module. The stresses on these fixing elements are therefore high, introducing a risk of breakage of these fixing or attachment elements. Each of the components of the heat exchange module must comprise fixing means such as lugs for fixing it to the cooling radiator, thereby increasing its fabrication cost. Furthermore, the condenser of the air

conditioning circuit and the motor-fan unit are fixed either side of the cooling radiator, which complicates the assembly of the heat exchange module because it is necessary to gain access to both faces of the radiator. No air sealing is provided between the different heat exchangers of the module, such that a fraction of the air may escape through the space between the exchangers, which reduces the efficiency of the exchangers. Finally, the supercharge air radiator is usually mounted separately. It is not part of the heat exchange module.

The subject of the present invention is a heat exchanger support system that remedies these disadvantages. Another subject thereof is a heat exchange module comprising such a support system.

Summary of the invention

According to the invention, the support system consists of a frame comprising faces furnished with fixing means for fixing at least a first and a second heat exchanger component, each component being fixed directly to the frame independently of the other components, the frame also comprising attachment elements allowing it to be mounted on a motor vehicle chassis via flexible vibration-damping means.

The expression "heat exchange components" refers to the heat exchangers themselves, such as the radiator to cool the engine or a condenser of an air conditioning circuit, but also other equipment such as the motor-fan unit and its air scoop etc.

Thanks to these features, the heat exchange components are easier to install and fix on the frame. Specifically, the means of fixing the heat exchange components are only on the frame itself. The components themselves, for example the heat exchangers, comprise no fixing means, in particular when they are not made

of plastic. Consequently, they are easier to design and produce.

Each heat exchanger, and more generally each heat exchange component, is mounted directly onto the frame in the fixing means specific to it. Consequently, the vibration-damping means of the frame are used for all the heat exchange components of the heat exchange module. It is not necessary to provide separate vibration-damping means for each heat exchange component.

The invention makes it possible to develop a range of standard heat exchange components. Each component may be used for different vehicles with a different frame for each vehicle. The frame may accept different details of each component, such as for example different sizes or thicknesses of radiators, thereby making it possible to have a single frame for a vehicle platform fitted with several power trains.

Given that the components are fixed independently of one another onto the frame by their own specific attachment elements, the heat exchange module can be easily dismantled for recycling at the end of the vehicle's life.

Finally, the frame provides the overall stiffness of the heat exchange module.

Preferably, each heat exchange component is kept in position independently in three orthogonal directions X, Y, Z.

This arrangement allows better control of the positional retention of the components and of the stresses that are exerted upon them. This makes it possible to reduce the risk of breakage of a component during its service life. It also allows fabrication

tolerances in each of the three orthogonal directions X, Y, Z to be compensated for. Advantageously, the frame forms a fairing for the heat exchange components. An air seal is provided between the periphery of each component and the frame, and the frame channels the air into the components.

Advantageously, the frame is designed in such a manner that the components are installed one behind the other, all from the same side of the frame.

This feature saves having to turn the frame around to attach the different components. Installation is therefore quicker and easier.

Advantageously, the profile of the lateral faces of the frames is such that they can be nested in one another.

Thus, the height of a stack of frames is reduced, thereby increasing the number of parts per container and reducing the transport cost.

According to one particular embodiment, certain fixing means consist of clips.

Advantageously, the fixing clips are S-shaped allowing a non-linear deformation.

Thus, after a degree of deformation allowing the component to be attached, the force necessary to deform the fixing element increases considerably so that its plastic deformation and breakage are avoided.

According to another embodiment, certain fixing means consist of flexible forms.

These flexible forms are used to accommodate tolerances of fabrication of the components.

According to yet another embodiment, the fixing means may consist of catches.

The catches are fixed. They are provided for example on one of the edges of the frame, the opposite edge comprising flexible fixing means such as clips.

Furthermore, the invention concerns a heat exchange module comprising a support system according to the invention in which heat exchange components are installed. These components may in particular be an engine cooling radiator, an air conditioning circuit condenser, a supercharge air cooler, etc.

Advantageously, the components do not of themselves comprise any fixing means, which simplifies their production as has been pointed out hereinabove.

In a preferred embodiment, the heat exchange module comprises at least a first and a second heat exchange component, the second component locking the first in the frame.

For example, if the first component is a condenser and the second the engine cooling radiator, it is impossible for the condenser to come out of its housing when the radiator is in place.

The heat exchange module can have a "mosaic" type architecture, or a surface type architecture.

Brief description of the drawings

Other features and advantages of the present invention will further appear on reading the following description of exemplary embodiments given for illustration purposes with reference to the appended figures, wherein:

- figure 1 is an exploded view in perspective of a heat exchange module comprising a support frame according to the present invention;

- figure 2 is a front view in perspective of the heat exchange module frame of figure 1;

- figure 3 is a view in section of the heat exchange module shown in figure 1;

- figure 4 is a partial view in perspective of the heat exchange module shown in figures 1 and 3;

- figure 5 is a rear view in perspective of the heat exchange module completely assembled;

- figures 6 to 10 show detail views of particular means of fixing the components onto the support frame;

- figure 11 is an exploded view in perspective of a variant of a heat exchange module according to the present invention;

- figure 12 is a view in perspective of three frames according to the invention nested in one another.

Description of the preferred embodiments

Figure 1 shows an exploded view in perspective of a heat exchange module comprising a support frame 2 according to the present invention, and figure 2 shows a front view in perspective of this frame. The frame 2, rectangular in shape, comprises two long sides and two short sides. The top long side comprises a lateral horizontal face 4 and the bottom long side comprises a lateral horizontal face 6. The short sides comprise lateral vertical faces, 8 and 10 respectively. The long sides also comprise front faces, 12 and 14 respectively, while the short sides comprise front faces 16 and 18 respectively. Finally, the top long

side of the frame comprises an inclined face 19 placed between the lateral horizontal face 4 and the front face 12. As can be seen more particularly in figure 3, which shows the frame in section, the horizontal face 10 comprises stiffening ribs 20.

The frame is divided into two portions by a vertical upright 22 which delimits a large opening 24 and a small opening 26. The frame also comprises fixing means that are used to fix it to the chassis of a motor vehicle. In the example shown, these means consist of two fixing pins 28 placed on the bottom portion of the frame on either side of it, and two fixing lugs 30 placed on the top portion of the frame and comprising cut-outs 32 allowing the passage of a fixing means such as a spindle or a bolt which may be combined with a flexible vibration-damping means (not shown).

The frame 2 comprises means for receiving and fixing various components belonging to the heat exchange module. In the example shown, the components comprise first a condenser 34 forming part of a motor vehicle air conditioning circuit, an engine cooling radiator 36 having two collector tanks 37, a motor-fan unit 38 for forced air circulation through the condenser 34 and the radiator 36. Finally, the components comprise a supercharge air radiator 40, intended to cool the air aspirated into the combustion chambers of the engine. Naturally, these examples of components are nonlimiting and the heat exchange module could comprise other components or additional components.

In the example shown, the heat exchange module comprises a "mosaic" type architecture. The left-hand portion of the frame 2 (according to figure 1) corresponding to the large opening 24 is assigned to housing the condenser 34 of the exchanger 36 and of the motor-fan unit 38, while the right-hand portion of the

frame corresponding to the small opening 26 is assigned to housing and attaching the supercharge air cooler 40.

According to the invention, the components are inserted into the frame 2, all from the same side, the rear face of the frame in the example shown. First the condenser 34 is inserted and fixed, then the radiator 36 and the motor-fan unit 38. The supercharge air radiator 40 is then fixed. Given that the heat exchange module comprises a mosaic type architecture, the order of installation could be reversed. In other words, the supercharge air radiator 40 could be fixed first, followed by the condenser 34, the exchanger 36 and the motor-fan unit 38.

Each of the components 34, 36, 38 and 40 comprises its own fixing means such that each element is fixed directly to the frame 2, independently of the other components. Given that flexible vibration-damping means (not shown) are provided between the chassis of the motor vehicle and the means 28, 30 of attachment between the frame 2 and the motor vehicle chassis, it is not necessary to provide vibration-damping means between the various components 34, 36, 38 and 40 and the frame 2. The production of the components and their installation into the frame are thus simplified and the cost of the heat exchange module is reduced.

There now follows a description of the individual fixing means of each of the components of the heat exchange module. The front face 14 is fitted with catches 42 (figure 6) which are used to keep the bottom portion of the condenser 34 in position in a direction X (figure 1) perpendicular to the plane of the frame 2. The top front face 12 comprises fixing means consisting of clips 44. These clips have properties of nonlinear stiffness. They deform easily to allow the insertion of the top edge of the condenser 34, but beyond this elastic deformation, their stiffness increases greatly.

This property is obtained by the special S-shape of the clips 44 (see figures 7 and 9). In addition, the clip 44 comprises a tongue 46 used to lock the condenser 34 after the installation of the exchanger 36, as will be explained hereinafter.

Furthermore, the front face 14 has, at each end of the large opening 24, catches 48 which limit the horizontal movement of the condenser 34 in a direction Y parallel with the long side of the frame 2. Thus it can be seen that the condenser 34 is kept in position independently in three orthogonal directions X, Y, Z, thereby facilitating control of the stresses exerted on this component and allowing greater production tolerances.

The means of fixing the cooling radiator 36 comprise two clips 50 provided on the long bottom horizontal side of the frame either side of the large opening 14. On the top portion of the frame 2, there are two clips 52 having an S-shape similar to that of the clips 44 for fixing the condenser 34, such as to have a property of nonlinear stiffness, as explained hereinabove.

In the direction X, perpendicular to the plane of the frame, the bottom edge of the cooling radiator 36 is kept in position by two catches 54 (figure 6) and by the lip 56 of the clip 50. On its top portion, it is retained in the direction X by a pressure on the front horizontal face 12 and by the lip 58 of the clip 52.

In the direction Y, the cooling radiator 36 is kept in position by flexible forms (not shown) situated at each end of the opening 24.

In the vertical direction Z, the cooling radiator 36 is kept in position by two flexible forms 60 which compensate for the production tolerances. At its bottom portion, the radiator 36 simply rests on the bottom horizontal opening of the large opening 24. Thus it can

be seen that the forms of the radiator are very simple, particularly the forms of the tanks 37. This allows a natural extraction from the mold of the plastic in which these tanks may be made and reduces the production cost of the radiator 36.

As can be seen more particularly in figure 3, the radiator 36 locks the condenser 34 when it has been inserted and fixed into the frame. Specifically, the collector tank 37 of the radiator 36 rests against the tongue 46 (figure 7) of the clip 44 which prevents this clip from moving and prevents the condenser 34 from being released.

Radiators of different dimensions may be inserted into the frame 2. For example, in the example shown, three sizes of radiator 36 may be installed, that is two different lengths and two different thicknesses, the height of the radiator remaining the same.

The motor-fan unit 38 comprises an air scoop 62 that surrounds an impeller 64 rotated by an electric motor 66 situated in the center of the impeller 64. The air scoop 62 also constitutes a support by which the motor-fan unit is installed onto the frame 2. Accordingly, the air scoop 62 comprises two top lugs 68 and two bottom lugs 70. The bottom lugs 70 are inserted into holes 72 of appropriate shapes made in the lateral horizontal face 6 of the frame 2. The lugs 70 are thus used to keep the motor-fan unit in position in the directions X and Y. The top lugs 68 are fixed to attachment elements 74 provided on the top portion of the large dimension opening 24 (see figures 1 and 10). The motor-fan unit is thus immobilized in the three directions X, Y and Z.

In order to allow the air scoop 62 to be used in different environments, it comprises symmetrical fixing elements which can be used to fix the motor-fan unit in

two different ways by a 180° rotation about the axis of the fan. Thus, the top lugs 68 take the place of the bottom lugs 70 and vice versa.

As can be seen more particularly in figure 3, a sealed connection is provided between each of the components, in particular the condenser 34, the exchanger 36 and the motor-fan unit 38, in order to prevent any loss of air so as to ensure the best possible thermal efficiency of the heat exchange module. This channeling of the air by the frame 2 requires the use of no additional parts.

The supercharge air radiator 40 is fixed in the same manner as the motor-fan unit 38. Specifically, it comprises on its bottom portion a fixing pin 78 which fits in a corresponding hole 80 formed in the frame 2 and on its top portion a fixing lug 82 which is fixed to an attachment element 84 provided on the long top horizontal side of the frame 2. The supercharge air radiator is thus kept in position in the three directions X, Y and Z.

As can be seen in figure 12, the frames 2 can be nested one inside the other thereby making it possible to reduce very considerably the bulk of a stack of frames. This makes it possible to fit more frames in a transport container and consequently reduces the cost of this method of transport. It will be noted in particular that the small lateral vertical faces 8 and 10 of the frame 2 comprise cut-outs 88 in which the fixing lugs 30 of another frame may fit. Cut-outs 90 will also be noted either side of the large top horizontal sides of the frame which allow the frames to be nested in one another.

Figure 11 shows a variant of the heat exchange module that has just been described with reference to figures 1 to 10. This heat exchange module is noteworthy for

its surface architecture whereas the heat exchange module in figures 1 to 10 has a mosaic type architecture. In figures 1 to 10, the supercharge air radiator 40 has a thickness that corresponds substantially to the thickness of the heat exchange module and it is placed laterally relative to the condenser and to the engine cooling radiator. On the other hand, in the embodiment of figure 11, the condenser 134, the cooling radiator 136 and the supercharge air cooler 140 extend across the whole area of the frame 2. However, the frame 2 is identical. In the same manner, the motor-fan unit 138 extends across the whole area of the frame. The condenser 134 is inserted first, as before. Then the supercharge air radiator 140 is installed followed by the engine cooling radiator 136. The supercharge air radiator 140 is thus placed in front of the cooling radiator 136. The means and principles of fixing each of these components are identical to those that have been described for the first variant, while changing what has to be changed, in particular concerning the placement of these fixing means. In particular, the large opening 24 and the small opening 26 have no further function. They are however retained in order to standardize the production of the frame 2. It will be noted furthermore, as previously mentioned, that the motor-fan unit has been rotated 180° about the axis of the impeller 64.